Title: Quilting Exploration with Polygons and Tessellations

Brief Overview:
This unit explores the mathematical explanations for patterns using repeating polygons to create designs. Students will use problem-solving skills and reasoning to create a quilt using polygons. They will analyze geometric relationships. They will be able to compare or classify quadrilaterals by length or sides and measures of angles. They will use squares, rectangles, rhombi, parallelograms and trapezoids. Students will explore patterns that repeat, tessellate or transform to create designs on a quilt. They will be able to identify lines of symmetry.

NCTM Content Standard/National Science Education Standard:
Geometry
- Analyze characteristics and properties of two- and three-dimensional geometric shapes and develop mathematical arguments about geometric relationships.
- Apply transformations and use symmetry to analyze mathematical situations.
- Use visualization, spatial reasoning, and geometric modeling to solve problems.

Measurement
- Understand measurable attributes of objects and the units, systems, and processes of measurement.
- Apply appropriate techniques, tools, and formulas to determine measurements.

Grade/Level:
Grades 4-5

Duration/Length:
Five days (45 to 50 minutes per day)

Student Outcomes:
Students will:

- Use polygons with no more than 8 sides as part of a composite figure comprised of triangles or quadrilaterals to determine area and perimeter.
- Analyze geometric relationships.
- Compare or classify quadrilaterals by length of sides and measures of angles.
- Use squares, rectangles, rhombi, parallelograms, and trapezoids.
- Compare triangles by sides.
- Congruence and Similarity.
- Analyze similar figures to identify or describe geometric figures as similar. Use same and different size.
- Measure with customary units. Select and use appropriate tools and units.

- Apply a variety of concepts, processes, and skills to solve problems.
- Identify the question in the problem.
- Make a plan to solve a problem.
- Apply a strategy, i.e. draw a picture, guess and check, find a pattern.
- Identify alternative ways to solve a problem.
- Reasoning: justify ideas or solutions with mathematical concepts or proof.
- Use methods of proof, i.e. direct, indirect, paragraph, or contradiction.
- Communication: present mathematical ideas using words, symbols, and visual display.
- Identify mathematical concepts in relationship to life.
- Use the relationship among mathematical concepts to learn other mathematical concepts.
-

Materials and Resources:
- Pattern blocks/tessellation patterns
- Rulers
- Large Note Paper Pads (to create KWL chart for whole classroom and journal quilt)
- White Paper
- Crayons
- Scissors and masking tape
- Glue
- KWL chart
- Student activity sheets and teacher resource sheets
- Book
- Journal quilt

Development/Procedures:
Lesson 1   Exploring Quilting Using Polygon and Tessellation Patterns

Reassessment – Teacher will ask students, "What do you know about creating a quilt? Does anyone have a quilt at home? How do you think it was created?" Students will participate in creating a KWL chart – by bringing their own experiences to the learning experience. Teacher will write student's knowledge on a large pad paper for the whole class to see. Students will get a K-W-L chart to write down information presented by the whole class. Teacher is able to reassess student based on their comments and student participation. This presents a great opportunity for students to share their ideas and misconceptions.

Launch – Using concept attainment, present students with Student Resource Sheet #1-A to review polygons. Have students share what they observed about polygons. Elicit their understanding of the concept of area and perimeter of polygons. Ask students, "What do you know about polygons?" Write down student's comments on large pad. At the same time, students will be reviewing and completing KWL chart.

Teacher Facilitation – Teacher reads a book on quilt (see Teacher Resource #1 - bibliography). Teacher directs students to look for patterns and problems. During the discussion, ask students if they have seen such patterns. Ask them, "How do you think such patterns were created". Write down some of the responses on KWL chart. Continue reading the rest of the book. Teacher will show examples of difference patterns to create quilts on the overhead projector (Teacher Resource #2, 3, and 4).

Student Application – Teacher (using Activity Sheet #1-B) leads class discussion: "Which shapes do you want to use in your quilt? Do you know what tessellation means? Which of the shapes tessellate? Which does not? Do you know what symmetry means? Is there a line of symmetry in patterns?" Go over the meaning of tessellation and symmetry. Keep in mind that you will discuss tessellation in lesson 3.

Have students work in groups (cooperative learning) to create and explore different shapes in various sizes using the pattern blocks and tessellation patterns. At this point students will explore more concepts on their own. They should start thinking about what kind of pattern they would like to create. Circulate to observe students using rubric assessment #1, 2, 3, or 4 (choose the most appropriate rubric for your use for this activity Teacher Resource #5, 6, 7 and 8).

Embedded Assessment – Students will be assessed by using Student Activity Sheet #1B on information covered in the lesson identifying polygons (finding area and perimeter).

Reteaching/Extension

- Review the different shapes of polygons and label them.
- Students will start coming up with an idea for his/her own design for the quilt.
- Homework – Describe a pattern you observe at home. Make a sketch of the pattern that most interests you.

Lesson 2   Finding the Area and Perimeter of Polygons

Preassessment - Hand out pattern blocks and have students recreate the pattern they have sketched for homework. They have to explain their pattern to the whole class.

Launch - Have students work in groups. Ask them: "What do you know about area and perimeter?" Hand out activity sheet 2-A. The students should be given about 5 minutes to discuss their knowledge within their group. Each group will present their knowledge to whole class. At this time, teacher will write down each response on the large KWL pad based on all information given from the different groups.

Teacher Facilitation – If students are not sure of what area and perimeter are, students will be given information about these concepts. For example, on the overhead projector, show the area and perimeter of a polygon. Pass out geoboards and Student Resource Sheet 2-B. Students will copy shapes that are presented on the overhead projector by the teacher. They will count together the different areas and perimeters. They are also to look for lines of symmetry.

Student Application – For practice and application, students will create more shapes on the geoboard and look for the area and perimeter. They will copy the shapes onto Student Resource Sheet 2-B and write down the area and perimeter.

Embedded Assessment - Have students discuss how they determined the area and perimeter of their shapes. Students will be assessed during and after each lesson to indicate how well the student understands the concepts of area and perimeter of polygons

Reteaching/Extension – Have students use the pattern blocks to investigate further the area and perimeter. Go over the meaning of area and perimeter. Model the different ways to find the area and perimeter. Ask students to explain how they are able to find the area and perimeter and look for lines of symmetry. Have students show on their geoboards the ways they found the area and perimeter.

Homework: Students are to find the area and perimeter of the sketch they created the previous night.

Lesson 3   **Introduction to Tessellation**

Preassessment - Review the term "tessellation" and observe the different shapes of tessellations. Point out that shapes like triangles, some quadrilaterals and hexagons are able to tessellate. Students will be able to select their shape based on patterns that are easy to tessellate. Students will review the concept of flip and slide.

Teacher Facilitation – On the overhead projector, explore the shapes that will tessellate using polygons shapes. Using Student Resource Sheet #3, model the activity, and then have students recreate the same shapes. Ask students: "Can this pattern tessellate? Do we have to flip or slide in order to tessellate?"

Student Application - Students will be given a bag of matching polygon tiles. Students will explore further to find different shapes that will tessellate. Students will draw a diagram of their different tessellated shapes on a white sheet of paper. Circulate to observe student activity. Ask students how they came up with their ideas.

Embedded Assessment – Students will write a paragraph to explain whether their shapes will or will not tessellate. Students will state whether they had to flip or slip the shape to tessellate. They will write about what they discovered through their experiment. Circulate and assist any student having difficulties and use Teacher Resource #5, 6, 7, or 8 (choose the most appropriate one for this activity).

Reteaching/Extension – Discuss and review tessellations using polygons. Have students demonstrate different examples of tessellations.

Homework. Students are to look for different patterns at home that will tessellate. They are to trace the pattern on paper and explain their findings.

Lesson 4   Creating the Quilt

Preassessment - Each student brings in their tessellated homework design. They are to present and describe the process they went through to design their product.

Teacher Facilitation – Tell students, "Today you are going to finally create your own design for our classroom quilt. You get to decide whether you want to use polygons or tessellation designs." Teacher and students will have a cooperative discussion on their final designs for the quilt.

Student Application – Student will choose and create his/her final design based on the previous lessons. They will be working in cooperative groups to help each student come up with their own design on white paper. If they have created a design from the past lesson, they are to expand the design. When they have created their design, they are to color it. When coloring, students are to press hard, but not break the crayon. Once everyone is finish, have student crumble the paper lots of times. They know their product is completed when the paper feels like cloth. The teacher is to gather all of the designs. Discuss with the student where each design should be placed to create the quilt. Use masking tape to connect each design.

Embedded Assessment – Students will demonstrate their knowledge of creating a pattern for the quilt through their final product (activity #4-A).

Reteaching/Extension – Students that are having difficulties creating their own design will be paired up with students that have a good foundation of creating a pattern. To wrap up the quilt lesson, students are to write a paragraph (activity #4-B journal quilt) on what they learned. This paragraph will be cut into a polygon design and paste onto a journal quilt.

Summative Assessment:

   Students will complete Student Resource Sheet #4-A on creating a quilt. Before completing the worksheet, they will create a design that will demonstrate polygons with symmetry, area and perimeter, or it will be able to tessellate. On Student Resource Sheet #4-A they will identify all geometric shapes and sizes, angle measured, and describe problems they had encountered and how they were able to solve it. Afterwards, to wrap up the lesson, the will write a paragraph on a journal quilt, explaining what they have learned in this unit. As an extension to the unit, students can create a book about polygons to read to primary students. The book should have short sentences and have pictures of polygons on each page.

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K-W-L CHART
Polygons

K WHAT WE KNOW	W WHAT WE WANT TO FIND OUT	L WHAT WE LEARNED

Teacher Resource 1

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    1996 ISBN# 0064434648.

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Teacher Resource 2
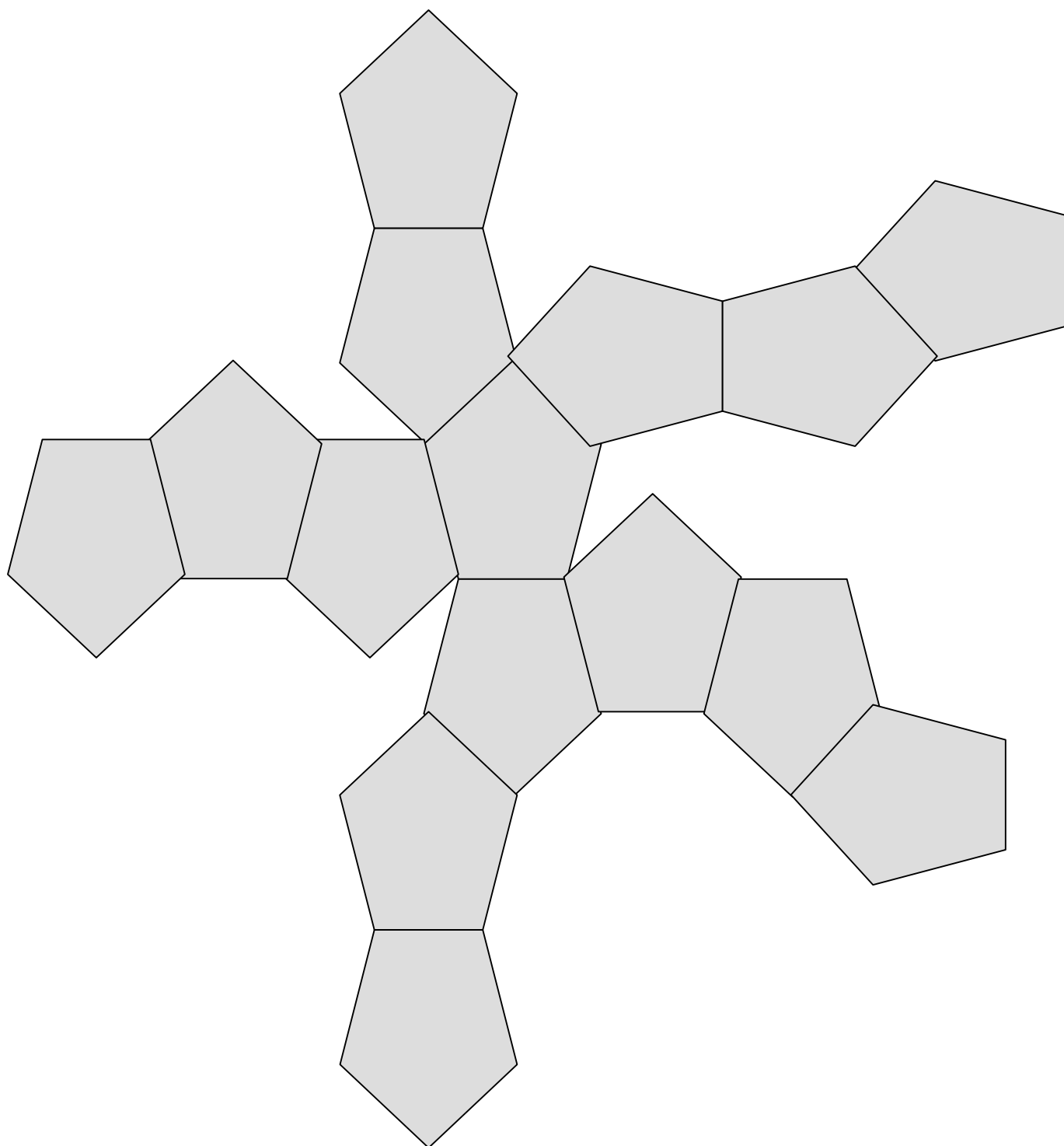
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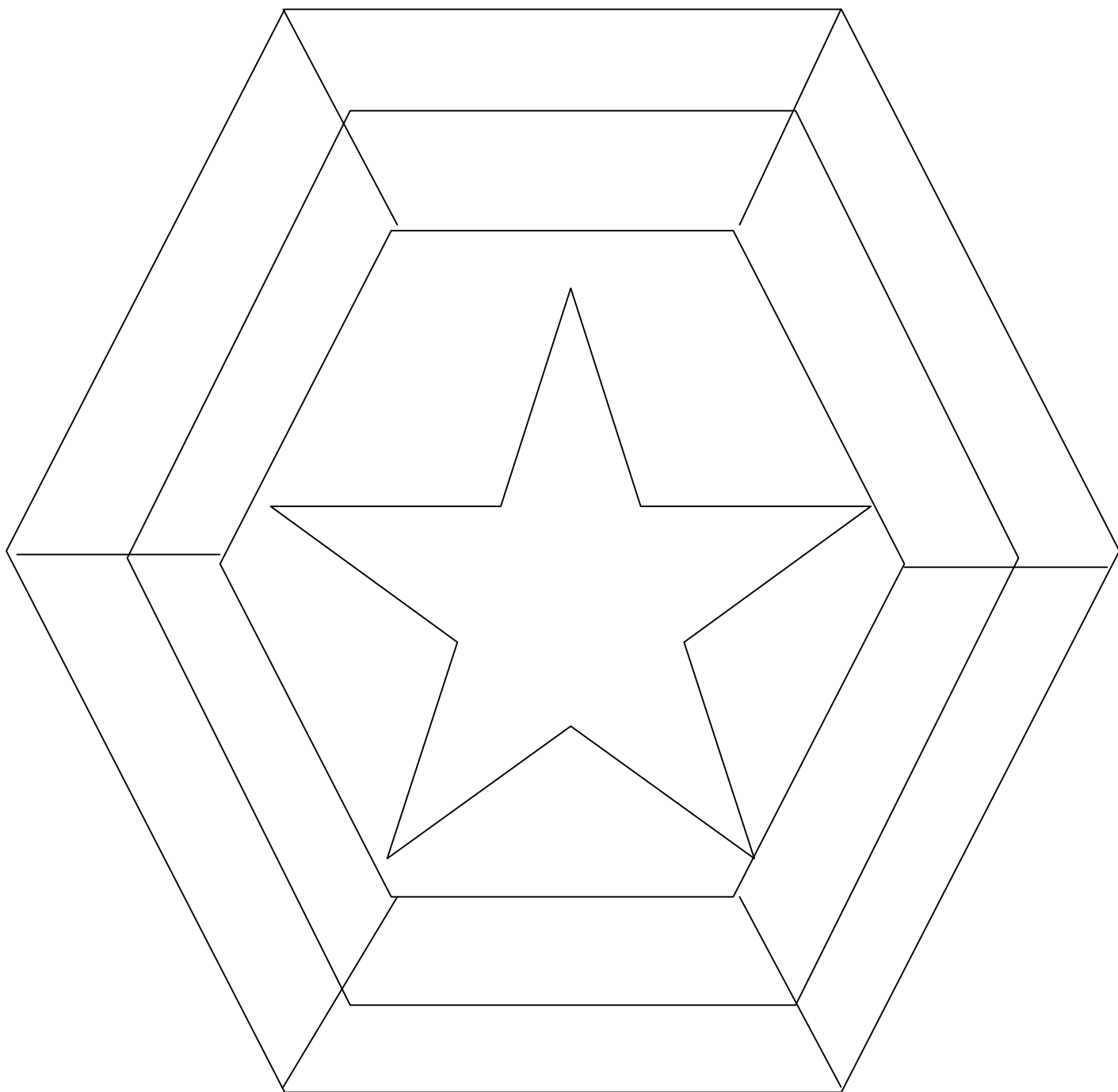
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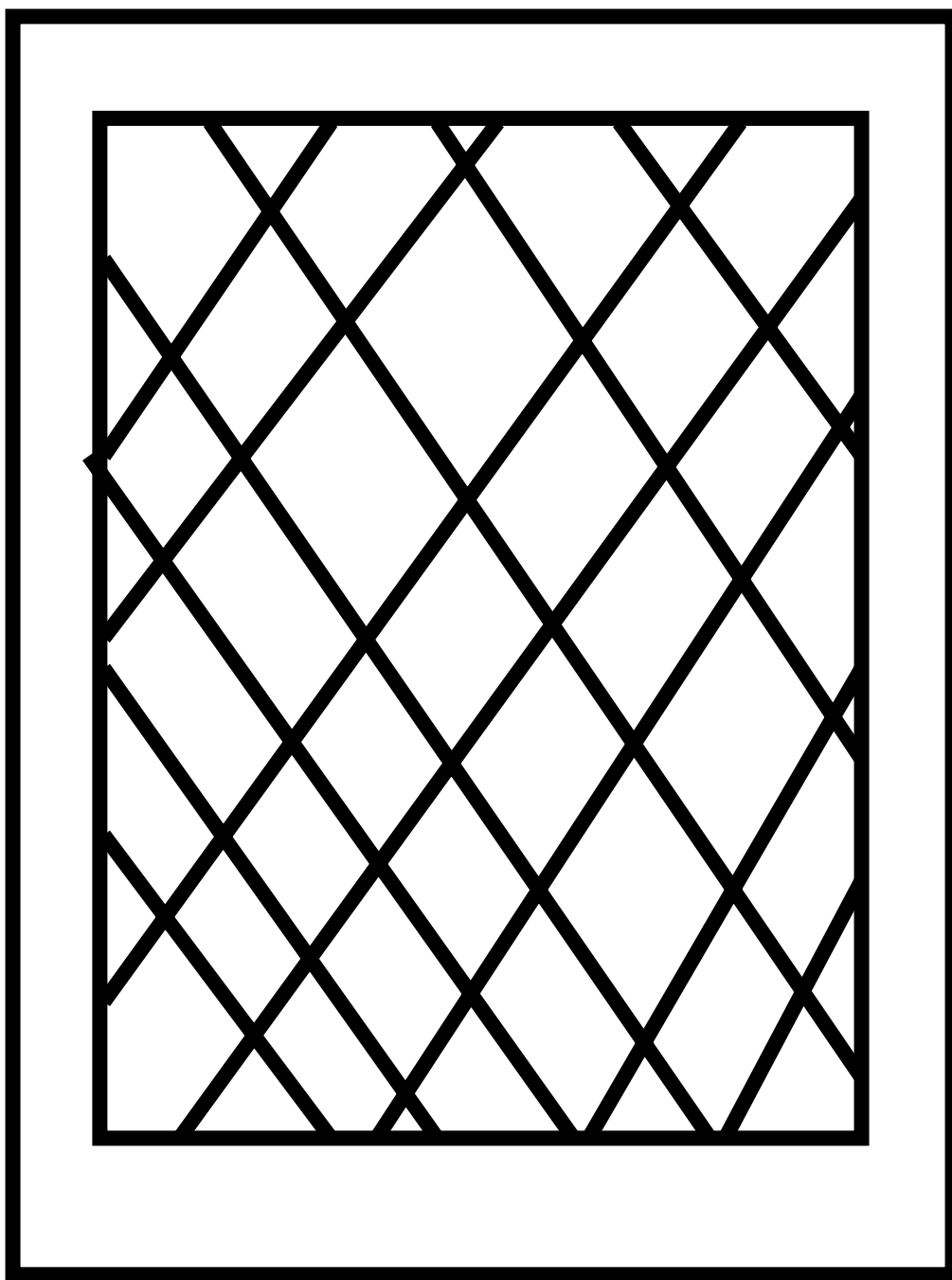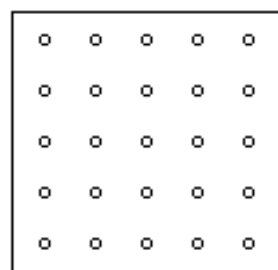
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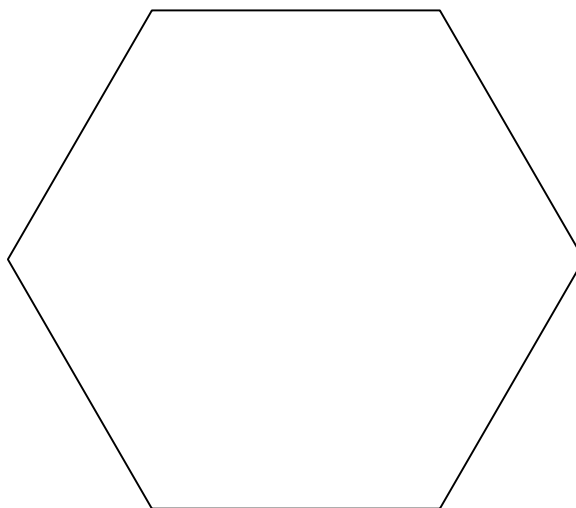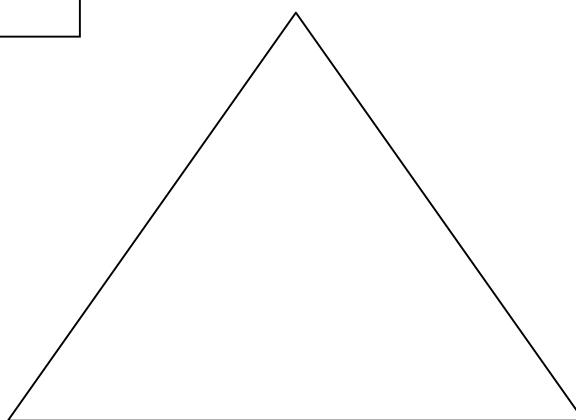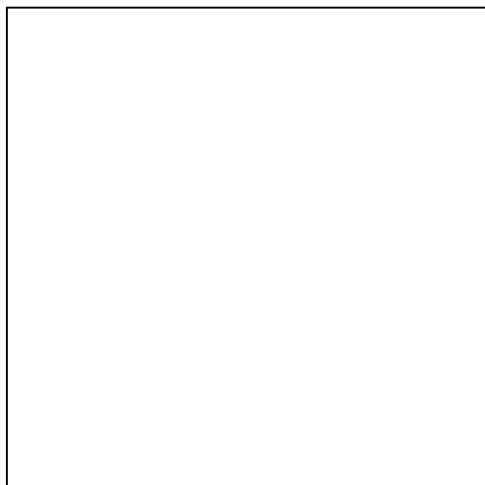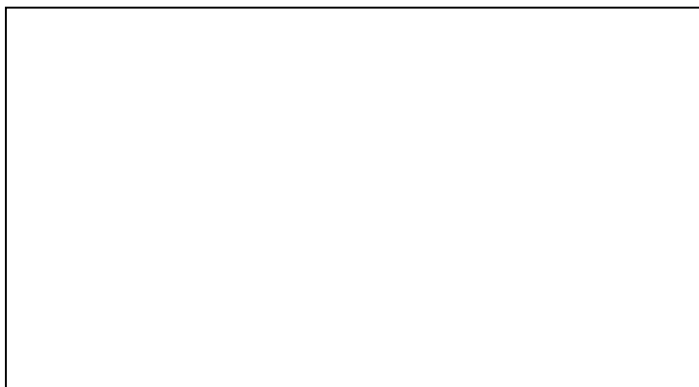
K-W-L CHART
Area and Perimeter

K WHAT WE KNOW	W WHAT WE WANT TO FIND OUT	L WHAT WE LEARNED

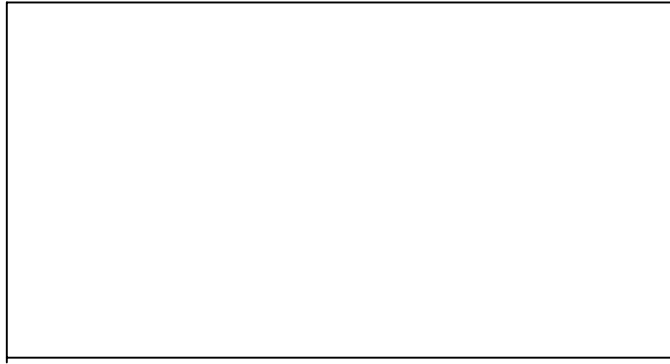Student Activity Sheet 2-B

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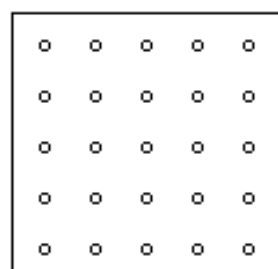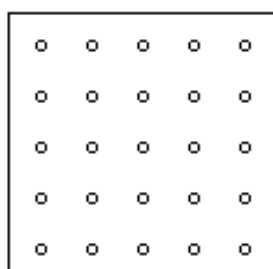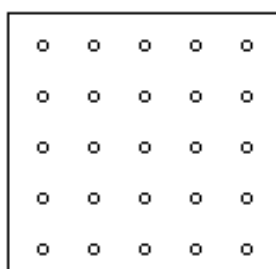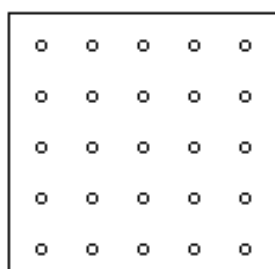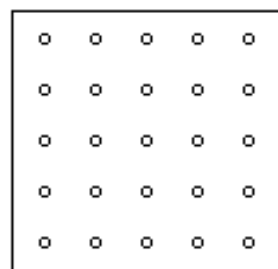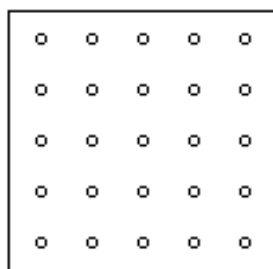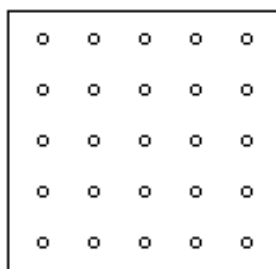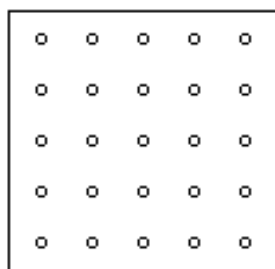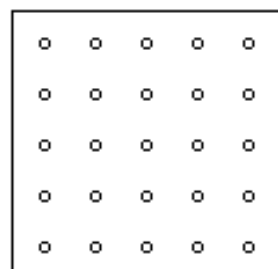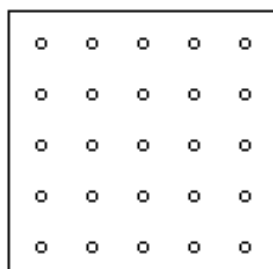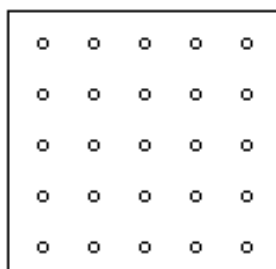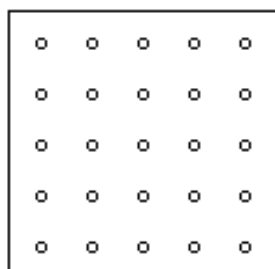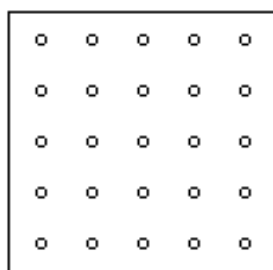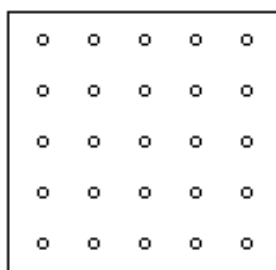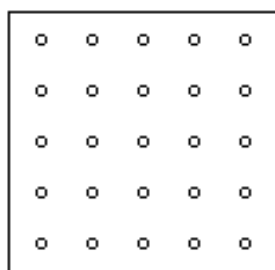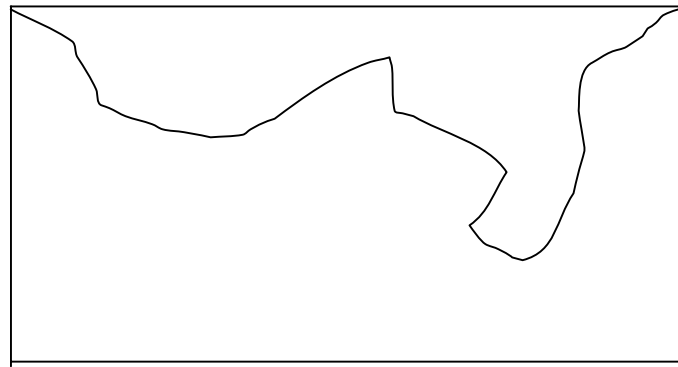
Tessellation Steps
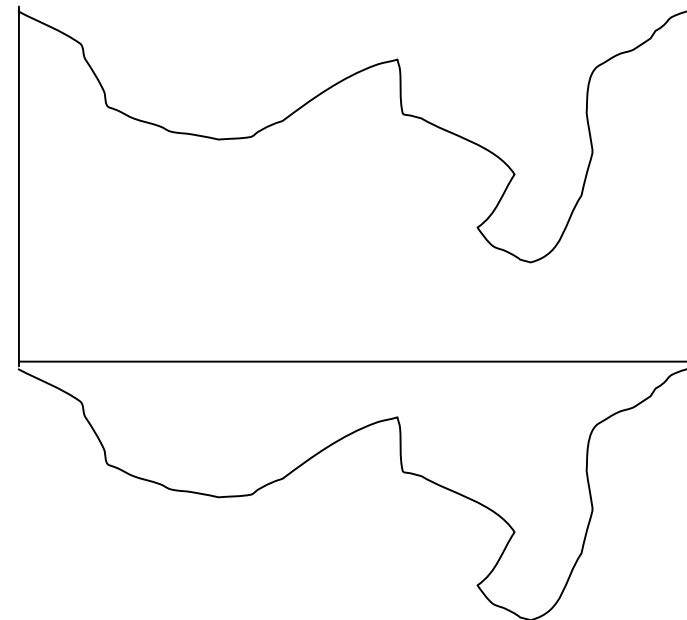## Student Resource Sheet #3

Step one
Cut out a rectangle.

Step Two
Draw a line from one vertex to the other. Cut along the line.

Step Three
Slide the cut piece to the opposite side, and then tape together.

* Repeat the process with shorter sides.

Teacher Resource 5

Rubric for Assessment 1 Pattern Block Quilt

- 4 Point   Student was able to identify and name the geometric shapes used in a tessellation to make a pattern, use transformation to create a quilt block, and make paper quilt with 90% accuracy.

- 3 Point   Student was able to identify and name the geometric shapes used in tessellation to make apattern, use transformation to create a quilt block, and make paper quilt with 80% accuracy.

- 2 Point   Student was able to identify and name the geometric shapes used in tessellation to make a pattern, use transformation to create a quilt block, and make paper quilt with 70% accuracy.

- 1 Point   Student makes an effort to identify and name the geometric shapes used in a tessellation to make a pattern, use transformation to create a quilt block, and make a paper quilt. None of the activities were completed.

Teacher Resource 6

Rubric for Assessment 2 Pattern Block Quilt

- 4 Point   Student identified and named all the geometric shapes used in a tessellation to make a pattern, the shapes that formed the central angle, identified tessellated or block type, and was able to discover the mathematical connections necessary to complete the quilt.

- 3 Point   Student identified and named at least four of the geometric shapes used in a tessellation to make a pattern, the shapes that formed the central angle, identified tessellated or block type and was able to discover the mathematical connections necessary to complete the quilt.

- 2 Point   Student identified and named at least three of the geometric shapes used in tessellation to make a pattern, the shapes that formed the central angle, identified tessellated or block type and was able to discover the mathematical connections necessary to complete the quilt.

- 1 Point   Student identified and named two of the geometric shapes used in tessellation to make a pattern, the shapes that formed the central angle, identified tessellated or block type and was able to discover the mathematical connections necessary to complete the quilt.

Teacher Resource 7
Rubric for Assessment 3 Pattern Block Quilt
MSA Mathematics BCR Rubric
Grades 3 through 8

2 The response demonstrates a complete understanding and analysis of a problem.
- Application of a reasonable strategy in the context of the problem is indicated.
- Explanation[1] of and/or justification[2] for the mathematical process(es) used to solve a problem is clear, developed, and logical.
- Connections and/or extensions made within mathematics or outside of mathematics are clear.
- Supportive information and/or numbers are provided as appropriate. [3]

1 The response demonstrates a minimal understanding and analysis of a problem.
- Partial application of a strategy in the context of the problem is indicated.
- Explanation[1] of and/or justification[2] for the mathematical process(es) used to solve a problem is partially developed, logically flawed, or missing.
- Connections and/or extensions made within mathematics or outside of mathematics are partial or overly general, or flawed.
- Supportive information and/or numbers may or may not be provided as appropriate. [3]

0 The response is completely incorrect, irrelevant to the problem, or missing. [4]

Notes:
[1] **Explanation** refers to students' ability to communicate **how** they arrived at the solution for an item using the language of mathematics.
[2] **Justification** refers to students' ability to support the reasoning used to solve a problem, or to demonstrate **why** the solution is correct using mathematical concepts and principles.
[3] Students need to complete rubric criteria for **explanation, justification, connections** and/or **explanation** as cued for in a given problem.
[4] An exact copy or paraphrase of the problem that provides no new relevant information will receive a score of "0".

3 The response demonstrates a comprehensive understanding and analysis of a problem.
- Application of a reasonable strategy in the context of the problem is indicated.
- Explanation[1] of and/or justification[2] for the mathematical process(es) used to solve a problem is clear, fully developed, and logical.
- Connections and/or extensions made within mathematics or outside of mathematics are clear and stated explicitly.
- Supportive information and/or numbers are provided as appropriate. [3]

2 The response demonstrates a general understanding and analysis of a problem.
- Application of a reasonable strategy in the context of the problem is indicated.
- Explanation[1] of and/or justification[2] for the mathematical process(es) used to solve a problem is feasible, but may be only partially developed.
- Connections and/or extensions made within mathematics or outside of mathematics are partial or overly general, or may be implied.
- Supportive information and/or numbers are provided as appropriate. [3]

1 The response demonstrates a minimal understanding and analysis of a problem.
- Partial application of a strategy in the context of the problem is indicated.
- Explanation[1] of and/or justification[2] for the mathematical process(es) used to solve a problem is logically flawed or missing.
- Connections and/or extensions made within mathematics or outside of mathematics are flawed or missing.
- Supportive information and/or numbers may or may not be provided as appropriate. [3]

0 The response is completely incorrect, irrelevant to the problem, or missing. [4]

Notes:
[1] **Explanation** refers to students' ability to communicate **how** they arrived at the solution for an item using the language of mathematics.
[2] **Justification** refers to students' ability to support the reasoning used to solve a problem, or to demonstrate **why** the solution is correct using mathematical concepts and principles.
[3] Students need to complete rubric criteria for **explanation, justification, connections** and/or **explanation** as cued for in a given problem.
[4] An exact copy or paraphrase of the problem that provides no new relevant information will receive a score of "0".

Creating a Quilt

Directions:

1. Create an original quilt design using pattern blocks or tessellation designs with white paper.
2. Identify all geometric shapes.
3. Identify all angle measures (area and perimeter).

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_____   _____

_____   _____

_____   _____

4. Identify all symmetric lines.
5. Identify all patterns that can tessellate.
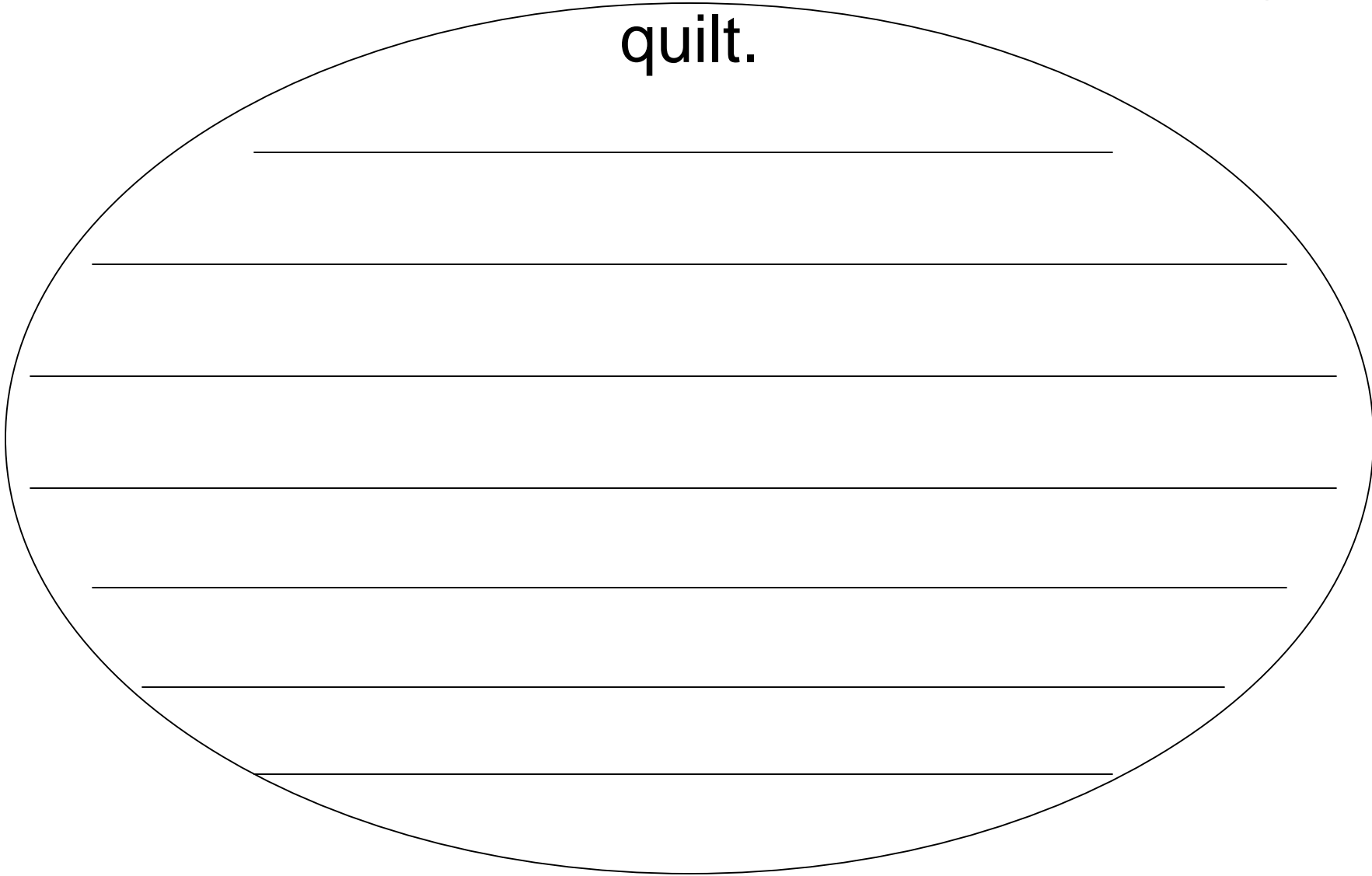
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_____   _____

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6. What are some of the problems you discovered while making your design, and how did you resolve them?

JOURNAL QUILT

Explain what you have learned on creating a quilt.

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